



**IntelliPack Series 892M/894M  
Computation Transmitters With  
Process Current/Voltage Inputs**

**USER'S MANUAL**

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## Safety Summary - Symbols on equipment:



Means "Caution, refer to this manual for additional information".

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**IMPORTANT SAFETY CONSIDERATIONS**

It is very important for the user to consider the possible adverse effects of power, wiring, component, sensor, or software failures in designing any type of control or monitoring system. This is especially important where economic property loss or human life is involved. It is important that the user employ satisfactory overall system design. It is agreed between the Buyer and Acromag, that this is the Buyer's responsibility.

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**1.0 INTRODUCTION**

These instructions cover hardware functionality of the transmitter models listed in Table 1. Supplementary sheets are attached for units with special options or features.

**Table 1: Models Covered in This Manual**

Series/ Input/Type	-Options/Output/ Enclosure/Approvals <sup>1</sup>	-Factory Configuration <sup>2</sup>
892M <sup>3</sup>	-0500	-C
894M <sup>3</sup>	-0500	-C

**Notes (Table 1):**

- Approvals: CE marked, UL Listed (USA & Canada) suitable for use in Class I, Division 2, Groups A, B, C, D Hazardous Locations, or Nonhazardous Locations only.
- Include the "-C" suffix to specify factory configuration option. Otherwise, no suffix is required for standard configuration.
- Model 894M-0500 units have four input channels, while 892M-0500 units have two input channels.

Module programming, transmitter operation, and the IntelliPack Configuration Software are also covered in the IntelliPack Transmitter Configuration Manual (8500-570).

**DESCRIPTION**

Series 89XM Computation Transmitters are members of the popular Acromag IntelliPack Transmitter & Alarm family. These models will accept two or four channels of DC current or voltage input, and provide an isolated process current or voltage output whose response is computed via a programmed mathematical combination of the input signals. Units are fully reconfigurable via our user-friendly Windows 95/98® or NT® IntelliPack Configuration Program. All IntelliPacks contain an advanced technology microcontroller with integrated downloadable flash memory for non-volatile program, configuration, calibration, and parameter data storage. Once configured, these modules may operate independent of the host computer for true embedded computation monitoring and control.

Modules may be field connected for either process current or DC voltage input or output signals. The 892M has two current or voltage inputs which may be mathematically combined to drive an isolated process current or voltage output, while the 894M provides up to four current or voltage inputs. A wide variety of math operators and functions are supported. On-board excitation is provided at the inputs to facilitate two-wire, 4 to 20mA process current transmitter hookup. Each channel includes a yellow LED on the front-panel to provide visual indication of an over-range input signal. Additionally, a green "Run" LED indicates power and operation status.

The module uses a high resolution, low noise, Sigma-Delta, Analog to Digital Converter ( $\Sigma\Delta$  ADC) to accurately convert the input signals into digitized values. An optically isolated Digital-to-Analog Converter (DAC) provides the corresponding process current or voltage output. All scaling and computation is performed using single-precision, floating point arithmetic.

Flexible computation transmitter functionality plus convenient reprogrammability makes this instrument extremely powerful and useful over a broad range of applications. Input operators for addition, multiplication, subtraction, and division are provided. The unit also provides functions for square root, absolute value, min/max selection, exponential, logarithmic, power, sine, cosine, tangent, arc-sine, arc-tangent, and arc-cosine generation, plus IF-THEN-ELSE conditional constructs. The output may produce a normal (ascending), or reverse (descending) response.

All IntelliPack modules are designed to withstand harsh industrial environments. They feature RFI, EMI, ESD, EFT, and surge protection, plus low temperature drift, wide ambient temperature operation, and isolation between input, output, and power. They also have low radiated emissions per CE requirements. As a wide-range DC-powered device, the unit may be powered from DC power networks incorporating battery back-up. Additionally, the input power terminal is diode-coupled, providing reverse polarity protection. This allows the unit to be connected to redundant power supplies, or several units to safely share a single DC supply.

Units are DIN-rail mounted and removable terminal blocks facilitate ease of installation and replacement, without having to remove wiring. Transmitter power and output wiring are inserted at one side of the unit, while input wiring is inserted at the other side. Connectors are an industry standard screw clamp type and accept a wide range of wire sizes.

The safe, compact, rugged, reconfigurable, and reliable design of this transmitter makes it an ideal choice for control room and field applications. Custom IntelliPack module configurations are also possible (please consult the factory).

#### Key IntelliPack 89XM Features

- **Agency Approvals** - CE, UL Listed, & cUL Listed.
- **Easy Windows® Configuration** - Fully reconfigurable via our user friendly Windows 95/98® or NT® IntelliPack Configuration Program.
- **Generous Mathematical Operator & Function Support** - This transmitter may mathematically combine up to four inputs using addition, subtraction, multiplication, and division. In addition, functions for square root, absolute value, min/max detection, exponential, logarithmic, power, sine, cosine, tangent, arc-sine, arc-tangent, and arc-cosine generation are supported. Conditional constructs with IF-THEN-ELSE are also included. Other functions are possible—please consult the factory.
- **IF-THEN-ELSE Support** - Module will evaluate a conditional formula using IF-THEN-ELSE, AND, OR, plus >, >=, <, <=, =, and <>.
- **Nonvolatile Reprogrammable Memory** - This module has an advanced technology microcontroller with integrated, non-volatile, downloadable flash memory and EEPROM. This allows the functionality of this device to be reliably reprogrammed thousands of times.
- **Fully Isolated** - Input, output, and power are isolated from each other for safety and increased noise immunity. Inputs share common and are not isolated channel-to-channel.
- **Universal Analog Outputs** - Supports process current output ranges of 0-20mA, 4-20mA, and 0-1mA, or 0-5V and 0-10V. Current outputs may drive up to 550Ω, typical. Voltage outputs include short circuit protection.

#### Key IntelliPack 89XM Features...continued

- **Convenient Scaling to Engineering Units** - Input & output signals are easily scaled to units & ranges convenient to your application.
- **Normal Or Reverse Acting Output Direction** - The output of this transmitter may be configured for a normal (ascending), or reverse (descending) response.
- **Output HOLD Function** - An external HOLD input terminal is provided that can be used to signal the module to hold the transmitter output at the last value.
- **Flexible DC Current or Voltage Inputs & Output** - The output and each input are individually configurable for several ranges of process current or voltage.
- **Convenient Input Excitation Supply** - The input includes an excitation supply for operation with two-wire transmitters.
- **Wide-Range DC-Powered** - This device operates from a wide DC supply range and the power terminal is diode-coupled. This makes this transmitter useful for systems with redundant supplies, and/or battery back-up.
- **Wide Ambient Operation** - The unit is designed for reliable operation over a wide ambient temperature range.
- **Hardened For Harsh Environments** - The unit will operate reliably in harsh industrial environments and includes protection from RFI, EMI, ESD, EFT, and surges, plus low radiated emissions per CE requirements.
- **Convenient Mounting, Removal, & Replacement** - The DIN-rail mount and plug-in type terminal blocks make module removal and replacement easy.
- **High-Resolution Precise A/D & D/A Conversion** - Includes a high-resolution, low noise, Sigma-Delta, Analog-to-Digital Converter ( $\Sigma\Delta$  ADC) and Digital-to-Analog Converter ( $\Sigma\Delta$  DAC), for high accuracy and reliability.
- **LED Indicators** - Used to indicate power and operation and channel status.

#### ACCESSORY ITEMS

The following IntelliPack accessories are available from Acromag. Acromag also offers other standard and custom transmitter and alarm types to serve a wide range of applications (please consult the factory).

#### IntelliPack Configuration Software (Model 5030-881)

IntelliPack alarms and transmitters are configured with this user-friendly Windows 95/98® or NT® Configuration Program. This software package includes the IntelliPack Alarm Configuration Manual (8500-563) and IntelliPack Transmitter Configuration Manual (8500-570). These manuals describe software operation and various alarm and transmitter functions in detail. The Configuration Software also includes an on-line help function. All transmitter and alarm functions are programmable and downloadable to the modules via this software. Non-volatile memory provides program, configuration, and data storage within the IntelliPack.

**IntelliPack Serial Port Adapter (Model 5030-913)**

This adapter serves as an isolated interface converter between the EIA232 serial port of the host computer and the Serial Peripheral Interface (SPI) port of the IntelliPack module. It is used in conjunction with the Acromag IntelliPack Configuration Software to program and configure the modules. This adapter requires no user adjustment, no external power, and operates transparent to the user. It receives its power from the IntelliPack module. The adapter has a DB9S connector that mates to the common DB9P serial port connector of a host computer. The adapter also has a 6-wire RJ11 phone jack to connect to the IntelliPack alarm module via a separate interconnecting cable (described below). Refer to Drawing 4501-635 for computer to IntelliPack connection details.

**IntelliPack Cable (Model 5030-902)**

This 6-wire cable is used to connect the SPI port of the IntelliPack Serial Port Adapter to the IntelliPack. This cable carries the SPI data and clock signals, reset signal, and +5V power and ground signals. The cable is 7 feet long and has a 6-wire RJ11 plug at both ends which snap into jacks on the Serial Port Adapter and the IntelliPack module.

**IntelliPack Software Interface Package (Model 800C-SIP)**

The IntelliPack Software Interface Package combines the Configuration Software (5030-881), Alarm Configuration Manual (8500-563), Transmitter Configuration Manual (8500-570), Serial Port Adapter (5030-913), and Cable (5030-902), into a complete kit for interfacing with IntelliPack Alarms and Transmitters.

## 2.0 PREPARATION FOR USE

### UNPACKING AND INSPECTION

Upon receipt of this product, inspect the shipping carton for evidence of mishandling during transit. If the shipping carton is badly damaged or water stained, request that the carrier's agent be present when the carton is opened. If the carrier's agent is absent when the carton is opened and the contents of the carton are damaged, keep the carton and packing material for the agent's inspection. For repairs to a product damaged in shipment, refer to the Acromag Service Policy to obtain return instructions. It is suggested that salvageable shipping cartons and packing material be saved for future use in the event the product must be shipped.

This module is physically protected with packing material and electrically protected with an anti-static bag during shipment. However, it is recommended that the module be visually inspected for evidence of mishandling prior to applying power.

This circuit utilizes static sensitive components and should only be handled at a static-safe workstation.



### INSTALLATION

The transmitter module is packaged in a general purpose plastic enclosure. Use an auxiliary enclosure to protect the unit in unfavorable environments or vulnerable locations, or to maintain conformance to applicable safety standards. Stay within the specified operating temperature range. As shipped from the factory, the unit is factory calibrated for all valid input ranges and has the default configuration shown in Table 3 below.

**WARNING:** Applicable IEC Safety Standards may require that this device be mounted within an approved metal enclosure or sub-system, particularly for applications with voltages greater than or equal to 75VDC or 50VAC.

**Table 3: 89XM Default Factory Configuration**

PARAMETER	CONFIGURATION/CALIBRATION
Input 1 Range <sup>4</sup>	0 to 10V DC <sup>4</sup>
Input 2 Range <sup>4</sup>	0 to 10V DC <sup>4</sup>
Input 3 & 4 Range <sup>1,4</sup>	0 to 10V DC, each channel <sup>1,4</sup>
Output Range <sup>2</sup>	0 to 10V DC (Jumper Installed) <sup>2</sup>
Output Mode	Normal Acting (Ascending Signal)
Input 1 Scaling	0-10V DC = 0-100
Input 2 Scaling	0-10V DC = 0-100
Input 3 Scaling	0-10V DC = 0-100
Input 4 Scaling	0-10V DC = 0-100
Output Scaling	0-100 = 0-10VDC
Equation <sup>3</sup> (892M-0500)	Output = A
Equation <sup>3</sup> (894M-0500)	Output = A

**Notes (Table 3):**

- Channels 3 & 4 of the Model 894M-0500 must be configured for the same input signal type and range, but they may be scaled differently.
- An external jumper is installed between the output "I+" and "JMP" terminals for voltage output. You must remove this jumper to use current output ranges.
- Variables A, B, C, & D are used in the output equation to represent input channels 1, 2, 3, & 4, respectively.
- For process current input ranges, a short jumper wire must be inserted between the input "I+" and "V+" terminals (not included). This jumper is removed for voltage input ranges.

Your application may differ from the default configuration and will require that the transmitter be reconfigured to suit your needs. This is accomplished with Acromag's user-friendly Windows 95/98® or NT® Configuration Program and Serial Port Adapter. It is usually more convenient to configure the module prior to field installation. See the Transmitter Configuration Manual (8500-570) for additional instructions.

**Jumper Installation (Current Input)**

For process current input, a short jumper wire must be installed between the input "I+" and "V+" terminals. This jumper is not included from the factory. Remove this jumper for voltage input applications. Refer to the Electrical Connections Drawing 4501-719.

### Jumper Installation (Voltage Output)

For voltage output, a short jumper must be installed between the output "I+" and "JMP" terminals. A jumper wire is included with the unit and has already been installed between the output "I+" and "JMP" terminals as shipped from the factory. Verify the position of this jumper if your application requires output voltage. Remove this jumper for current output applications. Refer to the Electrical Connections Drawing 4501-719.

### Mounting

Refer to Enclosure Dimensions Drawing 4501-720 for mounting and clearance dimensions.

**DIN Rail Mounting:** This module can be mounted on "T" type DIN rails. Use suitable fastening hardware to secure the DIN rail to the mounting surface. Units may be mounted side-by-side on 1-inch centers for limited space applications. **"T" Rail (35mm), Type EN50022:** To attach a module to this style of DIN rail, angle the top of the unit towards the rail and locate the top groove of the adapter over the upper lip of the rail. Firmly push the unit towards the rail until it snaps solidly into place. To remove a module, first separate the input terminal block(s) from the bottom side of the module to create a clearance to the DIN mounting area. Next, insert a screwdriver into the lower arm of the DIN rail connector and use it as a lever to force the connector down until the unit disengages from the rail.

### Electrical Connections

Terminals can accommodate wire from 14-24 AWG (stranded or solid copper). Strip back wire insulation 1/4-inch on each lead before installing into the terminal block. Input wiring should be shielded twisted-pair. Since common mode voltages can exist on signal wiring, adequate wire insulation should be used and proper wiring practices followed. It is recommended that transmitter output and power wiring be separated from the input signal wiring for safety, as well as for low noise pickup. Note that input, power, and output terminal blocks are a plug-in type and can be easily removed to facilitate module removal or replacement without removing individual wires. If your application requires voltage output, you must install a jumper between the output "I+" and "JMP" terminals (pre-installed from the factory). Remove this jumper for current output applications. If your input is process current, you must also install a short jumper wire between the input "I+" and "V+" terminals to complete the input circuit. Be sure to remove power and/or disable the load before unplugging the terminals to uninstall the module, installing or removing jumpers, or before attempting service. All connections must be made with power removed.

**IMPORTANT:** Power, input, and output I/O wiring must be in accordance with Class 1 Division 2 wiring methods, Article 501-4(b) of the National Electrical Code, NFPA 70, for installations in the U.S., or as specified in Section 18-1J2 of the Canadian Electrical Code for installations within Canada and in accordance with the authority having jurisdiction.

**This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D, or non-hazardous locations only.**

**CAUTION:** Risk of Electric Shock - More than one disconnect switch may be required to de-energize the equipment before servicing.

**WARNING:** Explosion Hazard - Substitution of any components may impair suitability for Class 1 Division 2.

**WARNING:** Explosion Hazard - Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

1. **Power:** Refer to Electrical Connections Drawing 4501-719. Variations in power supply voltage within rated limits has negligible effect on module accuracy. For supply connections, use No. 14 AWG wires rated for at least 75°C. The power terminal is diode-coupled for reverse polarity protection. Choose a power supply capable of providing the maximum steady state current draw of the module, plus the peak inrush current that is required when power is first switched on, or startup problems may occur. As a general rule, the peak current approaches twice the maximum steady state current. Peak currents are reduced with higher supply voltages.
  2. **DC Voltage/Current Inputs:** Connect input(s) per Drawing 4501-719. Observe proper polarity (see label for input type). An excitation supply is provided at the input for powering two-wire transmitters. For process current input, the input "I+" must be jumpered to the input "V+" terminal. Place a short jumper between these terminals to complete the input circuit for current inputs only. Voltage is delivered to the "V+" input directly with this jumper removed.
- Optional HOLD Wiring:** A TTL or open collector/drain signal may be wired to the HOLD and common (COM) terminals of the module to hold the transmitter output at the last computed value while HOLD is asserted low. HOLD is pulled-up internally (deasserted) and is part of the input circuit which is isolated from the output. HOLD common (COM) and input return (RTN) are not equivalent potentials and should never be tied together. Make sure that common is not inadvertently tied to ground which may be connected to input return.
3. **Analogue Output Connections:** Wire outputs as shown in Electrical Connections Drawing 4501-719. For voltage output, you must also install a jumper between the output "I+" and "JMP" terminals (pre-installed from the factory). Remove this jumper for current output. Current is delivered directly from the "I+" output with the jumper removed.
  4. **Grounding:** See Electrical Connections Drawing 4501-719. The module housing is plastic and does not require an earth ground connection. However, there are mounting positions at the output terminals to connect a cable shield, plus earth ground. These connections are isolated from the internal circuit and are recommended to minimize noise and help protect the unit from damaging I/O transients.

**WARNING:** For compliance to applicable safety and performance standards, the use of shielded cable is recommended as shown in Drawing 4501-719. Further, the application of earth ground must be in place as shown in Drawing 4501-719. Failure to adhere to sound wiring and grounding practices may compromise safety & performance.

### 3.0 MODULE CONFIGURATION

This computation transmitter needs to be configured for your application. An equation that relates the inputs to the output must be entered. Configuration is done using Acromag's Windows 95/98® or NT® IntelliPack Configuration Program and Serial Port Adapter. Transmitter configuration details are included in the IntelliPack Transmitter Configuration Manual (8500-570) and in Section 6 of this manual. The following section provides additional information regarding the formulation of the equation that relates the input signals to the output of this module.

#### MATH FORMULATION

The IntelliPack Configuration Software provides the interface for scaling the input and output values, and entering an equation via the transmitter configuration page. A simple edit box is provided to enter an equation that operates on the scaled input values from each channel. Equations are entered in a free-form format, similar to entering a cell formula in Microsoft Excel. All scaling and computation is performed using a single precision, floating point arithmetic. A simulator is provided to check scaling and computation.

The 894M model will mathematically combine up to 4 scaled input signal values according to a preprogrammed output equation entered via the IntelliPack Configuration Software. The equation combines standard math operators and functions, with floating point constants, and variables that represent the scaled input channel values. The module will compute a solution to the equation, then scale the computed value to the desired output range. The equation variables A, B, C, and D, represent the scaled input readings from channels 1, 2, 3, and 4, respectively.

The built-in equation interpreter operates on *scaled* input and output values. Scaled values are single-precision floating-point numbers representing your engineering units and are limited to 8 characters. Large numbers may be entered in scientific notation (i.e. 123456E3). Each input, plus the output must be scaled. That is, for each input, you must specify a scaled value for nominal zero and full-scale. For example, 4-20mA channel 1 can be scaled to 0-5000GPM—the 4mA input signal endpoint is scaled to 0GPM and the 20mA full-scale is scaled to 5000GPM. The solution to your equation determines your output (before scaling). The output equation solution must also be scaled to the nominal zero and full-scale endpoints of the selected output range.

Up to 200 characters may be entered into the equation field to define a formula that relates the scaled input values to the scaled output value. Note that equation constants can be entered as floating point numbers, or in scientific notation. Equation operators are shown in Table 3 below. Channels 1, 2, and 3/4 may have different input type and range configurations, but channels 3 and 4 (894M only) share a gain register in the A/D converter and must be configured with the same input range and type (they may be scaled differently).

Table 3A: IntelliPack 89xM Math Operators

OPERATOR	DESCRIPTION
+	Add (Do Not + Use To Indicate Polarity)
-	Subtract or unary minus for constants
*	Multiply
/	Divide
(	Left Parenthesis
)	Right Parenthesis
e	A constant followed by the suffix "e" or "E" represents scientific notation and a power of 10 follows (i.e. 5.25e8 = 525,000,000).
A	Represents the scaled value of channel 1
B	Represents the scaled value of channel 2
C	Represents the scaled value of channel 3
D	Represents the scaled value of channel 4

Table 3B: IntelliPack 89xM Math Functions

FUNCTION	DESCRIPTION
MIN( <i>n1,n2,...,n5</i> )	Return the minimum value of two to five channels, numbers, or expressions.
MAX( <i>n1,n2,...,n5</i> )	Return the maximum value of two to five channels, numbers, or expressions.
SQRT( <i>n1</i> ) <i>n1</i> >= 0	Return the square root of a channel, number, or expression.
ABS( <i>n1</i> )	Return the absolute value of a channel, number, or expression.
EXP( <i>n1</i> )	Compute the exponential ( $e^{n1}$ ) of a channel, number, or expression.
LN( <i>n1</i> ) <i>n1</i> > 0	Compute the natural logarithm (base $e$ ) of a channel, number, or expression.
LOG10( <i>n1</i> ) <i>n1</i> > 0	Compute the base 10 logarithm of a channel, number, or expression.
POWER( <i>n1,n2</i> )	Compute the channel, number, or expression <i>n1</i> raised to the <i>n2</i> power ( $n1^{n2}$ ).
SIN( <i>n1</i> ) <i>n1</i> is in radians	Compute the sine of a channel, number, or expression.
COS( <i>n1</i> ) <i>n1</i> is in radians	Compute the cosine of a channel, number, or expression.
TAN( <i>n1</i> ) <i>n1</i> is in radians	Compute the tangent of a channel, number, or expression.
ASIN( <i>n1</i> ) $-1 \leq n1 \leq 1$	Compute the arc-sine ( $\sin^{-1}$ , $-\pi/2 \leq$ radians $\leq \pi/2$ ) of a channel, number, or expression.
ACOS( <i>n1</i> ) $-1 \leq n1 \leq 1$	Compute the arc-cosine ( $\cos^{-1}$ , $0 \leq$ radians $\leq \pi$ ) of a channel, number, or expression.
ATAN( <i>n1</i> )	Compute the arc-tangent ( $\tan^{-1}$ , $-\pi/2 \leq$ radians $\leq \pi/2$ ) of a channel, number, or expression.
IF( <i>condition</i> ) THEN( <i>n1</i> ) ELSE( <i>n2</i> )	Conditional Expression. If the conditional expression is true, then the expression <i>n1</i> is performed, otherwise the expression <i>n2</i> is performed. Can only be used one time in a formula. ELSE must be included.
AND( <i>n1,n2,...,n5</i> )	Conditional construct AND of two to five channels, numbers, or expressions. True if all <i>n1</i> .. <i>n5</i> are true. Can only be used inside the conditional expression for IF.

**Table 3B: IntelliPack 89xM Math Functions...continued**

FUNCTION	DESCRIPTION
<b>OR(n1,n2,...,n5)</b>	Conditional construct OR of two to five channels, numbers, or expressions. True if any one or more of n1..n5 are true. Can only be used inside the conditional expression for IF.
<	Conditional construct -less than.
<=	Conditional construct -less than or equal to.
>	Conditional construct -greater than.
>=	Conditional construct -greater than or equal to.
=	Conditional construct -equal to.
<>	Conditional construct -not equal to.

**Notes (Table 3):**

1. In the table, "n" is used to represent a channel variable, number, or expression (another function or equation).
2. Do not use the plus symbol as a polarity indicator, it is only used for the add operation.
3. Do not type or embed space between the sign of a number and the number itself.
4. Do not type or embed space between the function keyword and left parenthesis.

**Show Simulator**

The IntelliPack Configuration Software also provides a Show Simulator function that you can use to test your formula and ensure that a correct output response within range is produced, without having to drive the inputs with real world signals. For each input, a slider control is provided to simulate the input signal. For fine control of the slider, use the left and right arrow keys. The corresponding output value is displayed using scaled units, and signal units (voltage or current). Error checking in this area is limited and it is up to the user to verify correct output formulation for all possible conditions of input. As such, use of the Show Simulator function is highly recommended for critical control applications. Computations that return values beyond the defined range will be "clipped" to the minimum or maximum scaled values to ensure that a valid output response is always returned.

The following example equations are entered into the Equation field exactly as they are shown below.

**Equation Examples**

Compute the average of 4 signals -  
(A + B + C + D)/4

Compute the smallest square root of 3 input signals -  
MIN(SQRT(ABS(A)), SQRT(ABS(B)), SQRT(ABS(D)))

Compute the square of the scaled value of channel 1 -  
POWER(A,2)

Compute the sum of the minimum and maximum of 4 signals -  
MIN(A, B, C, D) + MAX(A, B, C, D)

Compute the maximum of 4 different signals greater than 10 -  
MAX(A, B, C, D, 10)

Conditional expression examples -  
IF(AND(A>B,C=D)) THEN(A\*2) ELSE(B\*3)

IF(OR(A>=B,A=D)) THEN(A) ELSE(C) - 12.56

When formulating an equation or response, it is important to keep the limits of module resolution in mind (see Table 5). In some cases, it may be necessary to normalize your variables or output response. Always use the Show Simulator function to test your equation over the full range of input to ensure a valid output response. A computation that returns a value beyond the defined range will be "clipped" to the minimum or maximum scaled values to ensure a valid response is always returned. Due to memory constraints of the module, some equations may be too complex and an error will be indicated in the Show Simulator screen.

**HOLD Function**

This module also includes a HOLD input terminal that affects the output response. With HOLD deasserted (set HIGH or left open with respect to COM terminal), the output will track the result of the input equation. However, if HOLD is asserted (set LOW or shorted to COM), then the output will remain at the result of the last computation until HOLD is deasserted. Note that the input HOLD signal is driven with respect to input COM. Input COM and RTN are not the same potential and should never be connected together, either directly or through ground. Do not ground COM.

**4.0 THEORY OF OPERATION**

Refer to Simplified Schematic 4501-717 and Functional Block Diagram 4501-718 to gain a better understanding of the circuit. Note that this transmitter will pre-filter a signal and convert the signal to a scaled voltage--either through a voltage divider circuit (voltage input), or a current sink resistor (current input). An A/D converter stage then applies appropriate gain to the signal, performs analog-to-digital conversion, and digitally filters the signal. The digitized signal is then transmitted serially to a microcontroller. The microcontroller completes the transfer function according to its configuration and programmed equation, and then sends a scaled output signal to an optically isolated Digital-to-Analog Converter (DAC). The DAC then updates its current or voltage output in response. If HOLD is asserted, then the output will remain at the last value until HOLD is deasserted. With HOLD deasserted (set HIGH or left open), the output will track the result of the input equation. The embedded configuration and calibration parameters are stored in non-volatile memory integrated within the microcontroller. Only the functions required by an application are actually stored in memory--new functionality can be downloaded via the IntelliPack Configuration Program and Serial Port Adapter. A wide input range switching regulator (isolated flyback mode) provides isolated +5V and +16V power to the circuit, plus an isolated +15V output circuit supply.

## 5.0 SERVICE AND REPAIR

**CAUTION:** Risk of Electric Shock - More than one disconnect switch may be required to de-energize the equipment before servicing.

### SERVICE AND REPAIR ASSISTANCE

This module contains solid-state components and requires no maintenance, except for periodic cleaning and transmitter configuration parameter (zero, full-scale, setpoint, deadband, etc) verification. Since Surface Mounted Technology (SMT) boards are generally difficult to repair, it is highly recommended that a non-functioning module be returned to Acromag for repair. The board can be damaged unless special SMT repair and service tools are used. Further, Acromag has automated test equipment that thoroughly checks and calibrates the performance of each module. Please refer to Acromag's Service Policy Bulletin or contact Acromag for complete details on how to obtain service parts and repair.

### PRELIMINARY SERVICE PROCEDURE

Before beginning repair, be sure that all installation and configuration procedures have been followed. The unit routinely performs internal diagnostics following power-up or reset. During this period, all LED's will turn ON momentarily, and the green "Run" LED flashes. If the diagnostics complete successfully, the "Run" LED will stop flashing after approximately one second and remain ON. This indicates that the unit is operating normally. If the "Run" LED continues to flash, then this is indicative of a problem. In this case, use the Acromag IntelliPack Configuration Software to reconfigure the module or download its firmware and this will usually cure the problem. If the diagnostics continue to indicate a problem (a continuously flashing green LED), or if other evidence points to a problem with the unit, an effective and convenient fault diagnosis method is to exchange the questionable module with a known good unit.

The IntelliPack Serial Port Adapter also contains a red LED visible at the small opening in the enclosure to the right of the RJ11 receptacle. If this LED is OFF or Flashing and power is ON, then a communication interface problem exists. Note that the adapter receives its power from the IntelliPack module. A constant ON LED indicates a properly working and powered serial interface adapter.

Acromag's Application Engineers can provide further technical assistance if required. When needed, complete repair services are available from Acromag.

## 6.0 SPECIFICATIONS

**892M-0500-C**, Two I/V Inputs, Single Process I/V Output  
**894M-0500-C**, Four I/V Inputs, Single Process I/V Output

**General:** The IntelliPack Model 89XM-0500 is a DC-powered computation transmitter which mathematically combines up to four channels of process current or voltage, and provides an isolated current or voltage output that is the result of a programmed equation that operates on the inputs. Isolation is supplied between the input, output, and power.

Input channels share common and are not isolated from each other. This transmitter is DIN-rail mounted.

The unit is configured and calibrated with our user-friendly Window 95/98® or NT® IntelliPack Configuration Program. All calibration and configuration information is stored in non-volatile reprogrammable memory in the module.

### MODEL NUMBER DEFINITION

Transmitters are color coded with a white label. The prefix "8" denotes the IntelliPack Series 800, while the "M" suffix specifies that this device is primarily a computation (Math) transmitter.

**89xM:** Provides a resultant isolated DC current or voltage output response to a mathematical equation that combines up to two or four DC voltage or current inputs.

**-0500:** The four digits of this model suffix represent the following options, respectively:

- 0 = Relay: No Alarm Relay;
- 5 = Output: Transmitter Voltage or Current;
- 0 = Enclosure: DIN rail mount;
- 0 = Approvals: CE marked, UL Listed (USA & Canada) suitable for use in Class I, Division 2, Groups A, B, C, D Hazardous Locations, or Nonhazardous Locations only.

### INPUT SPECIFICATIONS

Unit must be wired and configured for the intended input types and ranges (see Installation Section for details). The following paragraphs summarize this model's input types, ranges, and applicable specifications.

**DC (Process) Current:** 0-1mA, 0-20mA, and 4-20mA. All input ranges are subsets of the 0-20mA input range. A precision 49.9Ω current sink resistor is placed in the I+ input lead and converts the input current to a voltage that is processed by the A/D converter. Input I+ must be jumpered to the V+ terminal to utilize current input. This module also provides an excitation supply (15VDC/48mA) for use with 2-wire transmitters.

**Current Input Reference Test Conditions:** 4 to 20mA input (jumper installed); Ambient Temperature = 25°C; Power Supply = 24VDC; Output = 4-20mA, Normal Acting; Output Formula = average of combined inputs [(A + B + C + D)/4].

**Input Overvoltage Protection:** Bipolar Transient Voltage Suppressors (TVS), 18V clamp level typical.

**Input Resistance:** 550KΩ, typical.

**DC Voltage (10:1 Input Divider):** 0-5VDC or 0-10VDC.

**Voltage Input Reference Test Conditions:** 0 to 10V DC input; Ambient Temperature = 25°C; Power Supply = 24V DC; Output = 4-20mA, Normal Acting; Output Formula = average of all inputs [(A + B + C + D)/4].

**Input Overvoltage Protection:** Bipolar Transient Voltage Suppressors (TVS), 18V clamp level typical.



**General Input Specifications**

**Input Accuracy:** Better than  $\pm 0.05\%$  of input span, typical. Better than  $\pm 0.3\%$  of input span, typical for 0-1mA range. This includes the effects of repeatability, but not sensor error. This refers to input accuracy only, but does not include analog output accuracy (see Table 6). Add input accuracy to output accuracy to obtain worst case inaccuracy from input to output for a given I/O configuration.

**Accuracy Versus Temperature:** Better than  $\pm 0.005\%$  of input span per  $^{\circ}\text{C}$ , or  $\pm 1\mu\text{V}/^{\circ}\text{C}$ , whichever is greater.

**Resolution:** See Table 5.

**Input Bias Current:**  $\pm 100\text{nA}$  maximum, excluding excitation current of process current inputs.

**Input Filter:** Normal mode filtering, plus digital filtering, optimized and fixed per input range within the  $\Sigma$ - $\Delta$  ADC.

**Noise Rejection (Normal Mode):** 40dB @ 60Hz, typical with 100 $\Omega$  input unbalance (49.9 $\Omega$  for process currents).

**Noise Rejection (Common Mode):** 100dB @ 60Hz, typical with 100 $\Omega$  input unbalance (49.9 $\Omega$  for process currents).

**Analog to Digital Converter (A/D):** A 16-bit  $\Sigma$ - $\Delta$  converter, Analog Devices AD7714AR-5.

**Input Conversion Rate:** 5 conversions per second per channel (894M), 8 conversions per second per channel (892M).

**Input Excitation Supply:** +15V DC typical with respect to input common (COM), current limited to approximately 50mA. For use with two-wire process current transmitters. This will power up to two 2-wire transmitters.

**Input Scaling:** The configuration software is used to scale the nominal input signal range endpoints indicated, to values representative of the your application's engineering units. Constants are limited to 8 characters and may be entered as floating point numbers or using scientific notation. If you wish to use a subset of the nominal input range, then you will have to extrapolate the corresponding scaling values as required.

**HOLD (External Input Terminal):** A TTL or open collector/drain signal (5V logic) may be wired directly to the HOLD and COM terminal of the module to hold the transmitter's output at the last value while HOLD is asserted. HOLD is asserted low and pulled-up internally. The HOLD circuit is part of the input circuitry and is isolated from the output circuit.

**Table 5: Effective Resolution Per Nominal Input Range**

Gain $A_V$	Nominal Input Range	Effective Bits/ A/D Resolution
128	0-1mA DC	16797/ 60nA/LSB
8	0-20mA DC	20996/ 953nA/LSB
8	4-20mA DC	16797/ 953nA/LSB
2	0-5V DC	26298/ 190uV/LSB
1	0-10V DC	26298/ 380uV/LSB

**IMPORTANT:** Input COM and RTN are not the same potential and should never be connected together, either directly or through ground. Do not tie COM to ground.

**ANALOG OUTPUT SPECIFICATIONS**

These units contain an optically isolated DAC (Digital-to-Analog Converter) that provides a process current or voltage output. Note that calibration can only occur with respect to one of the outputs, voltage or current, and only one of the outputs may operate at a time. A jumper is required between the output "I+" and "JMP" terminals for voltage output. Remove this jumper for current output.

**Voltage Output Specifications:**

**Output Range:** 0-10V DC, 0-5V DC.

**Output Accuracy:** See Table 6.

**Output Current:** 0-10mA DC maximum.

**Output Impedance:** 1 $\Omega$ .

**Output Resolution:** See Table 6.

**Output Short Circuit Protection:** Included

**Current Output Specifications:**

**Output Ranges:** 0-20mA DC, 4-20mA DC, or 0-1mA DC.

**Output Maximum Current:** 21.6mA typical.

**Output Accuracy:** See Table 6.

**Output Compliance:** 10V Minimum, 12V Typical.

**Output Resolution:** See Table 6.

**Output Load Resistance Range:** 0 to 550 $\Omega$ , typical.

**Table 6: Analog Output Range Resolution & Accuracy**

Output Range	Resolution	Output Accuracy <sup>1,2</sup> Percent-of-Span
0 to 20mA DC	0.0025%	0.025%
4 to 20mA DC	0.0025%	0.025%
0 to 1mA DC	0.0370%	0.300%
0 to 10V DC	0.0025%	0.025%
0 to 5V DC	0.0030%	0.050%

**Notes (Table 6):**

1. Voltage outputs unloaded. Loading will add "I\*R" error.
2. Software calibration produces high overall accuracy.
3. All output current and voltage ranges are subsets of the 0-20mA range.
4. Worst case input-to-output inaccuracy can be calculated by adding input accuracy to output accuracy.

**General Output Specifications**

**Digital-to-Analog Converter:** Analog Devices AD420AR-32, 16-bit  $\Sigma$ - $\Delta$ . Monotonic to 16 bits.

**Integral Non-Linearity:**  $\pm 0.002\%$  ( $\pm 1.4\text{LSB}$ ) of span typical, 0.012% ( $\pm 7.9\text{LSB}$ ) of span maximum, for ranges utilizing full output span (0-24mA, 0-10V DC).

**Output Temperature Drift:** Better than  $\pm 20\text{ppm}/^{\circ}\text{C}$  Typical,  $\pm 50\text{ppm}/^{\circ}\text{C}$  Maximum.

**Output Response Time:** 800ms, typical, to 98% of output transition with a step change in the input.

**Output HOLD Function:** A TTL or open collector/drain signal (5V logic) may be wired directly to the HOLD and COM terminals of the module to hold the transmitter's output at the last value. HOLD is asserted low and pulled-up internally. The HOLD circuit is part of the input circuit and isolated from the output circuit. Note that input COM and RTN terminals are not equivalent potentials and should never be tied together, either directly or through ground. Be careful when making earth ground connections that input COM is not tied to earth ground, which may be connected to input RTN.

**Output Conversion Rate:** 5 updates per second (894M), 8 updates per second (892M).

**Output Scaling:** The configuration software is used to scale the nominal output signal range endpoints indicated, to values representative of the your output equation's engineering units. Constants are limited to 8 characters and may be entered as floating point numbers or using scientific notation. If you wish to use a subset of the nominal output range, then you will have to extrapolate the corresponding scaling values as required.

## ENCLOSURE/PHYSICAL SPECIFICATIONS

Unit is packaged in a general purpose plastic enclosure that is DIN rail mountable for flexible, high density (approximately 1" wide per unit) mounting. See Enclosure Dimensions Drawing 4501-642 for details.

**Dimensions:** Width = 1.05 inches, Height = 4.68 inches, Depth = 4.35 inches (see Drawing 4501-642).

**DIN Rail Mounting (-xx0x):** DIN rail mount, Type EN50022; "T" rail (35mm).

**Connectors:** Removable plug-in type terminal blocks; Current/Voltage Ratings: 15A/300V; Wire Range: AWG #14-24 solid or stranded; separate terminal blocks are provided for input 1 & 2, input 3 & 4, power & output, and hold/excitation/output shield contacts. For supply connections, use No. 14 AWG copper wires rated for at least 75°C.

**Case Material:** Self-extinguishing NYLON type 6.6 polyamide thermoplastic, UL94 V-2, color beige; general purpose NEMA Type 1 enclosure.

**Printed Circuit Boards:** Military grade FR-4 epoxy glass.

**Shipping Weight:** 1 pound (0.45 Kg) packed.

## APPROVALS (-xxx0)

**0: Safety Approvals:** UL Listed (USA & Canada) suitable for use in Class I, Division 2, Groups A, B, C, D Hazardous Locations, or Nonhazardous Locations only.

## ENVIRONMENTAL SPECIFICATIONS

**Operating Temperature:** -25°C to +70°C (-13°F to +158°F).

**Storage Temperature:** -40°C to +85°C (-40°F to +185°F).

**Relative Humidity:** 5 to 95%, non-condensing.

**Power Requirements:** +10V Minimum to +36V DC Maximum.

Current draw is a function of supply voltage (see Table 8). Current shown in Table 8 assumes that the input excitation supply is delivering 44mA, and the output circuit is at 20mA. Current draw is given with and without the Serial Port Adapter connected. An internal diode provides reverse polarity protection. Your power supply must be adequate to provide the steady-state current shown below, plus the peak inrush current that occurs when power is switched on. As a general rule, your supply should be chosen to provide twice the current indicated below, or startup problems may occur.

**CAUTION:** Do not exceed 36VDC peak, to avoid damage to the module.

**Table 8: 89XM Supply Current**

Supply Voltage	Supply Current (SPA Connected)	Supply Current (SPA Not Connected)
10V	330mA	300mA
12V	250mA	230mA
15V	200mA	175mA
24V	120mA	110mA
36V	85mA	80mA

**Note:** Unloading the input excitation supply will reduce current consumption 30-45%.

**IMPORTANT - External Fuse:** If unit is powered from a supply capable of delivering more than 1A to the unit, it is recommended that this current be limited via a high surge tolerant fuse rated for a maximum current of 1A or less (for example, see Bel Fuse MJS1).

### Power Supply Effect:

**DC Volts:** Less than  $\pm 0.001\%$  of output span change per volt DC for rated power supply variations.

**60/120 Hz Ripple:** Less than 0.01% of output span per volt peak-to-peak of power supply ripple.

**Isolation:** Input, output, & power circuits are isolated from each other for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). This complies with test requirements outlined in ANSI/ISA-82.01-1988 for the voltage rating specified. Inputs share common and are not isolated from each other.

**Installation Category:** Designed to operate in an Installation Category (Overvoltage Category) II environment per IEC 1010-1 (1990).

**Electromagnetic Interference Immunity (EMI):** No output shift will occur beyond  $\pm 0.25\%$  of span, under influence of EMI from switching solenoids, commutator motors, & drill motors.

**Electromagnetic Compatibility (EMC):** CE marked, per EMC Directive 2004/108/EC.

### Immunity per BS EN 61000-6-1:

- 1) Electrostatic Discharge Immunity (ESD), per IEC 61000-4-2.
- 2) Radiated Field Immunity (RFI), per IEC 61000-4-3.
- 3) Electrical Fast Transient Immunity (EFT), per IEC 61000-4-4.
- 4) Surge Immunity, per IEC 61000-4-5.
- 5) Conducted RF Immunity (CRFI), per IEC 61000-4-6.

### Emissions per BS EN 61000-6-3:

- 1) Enclosure Port, per CISPR 16.
- 2) Low Voltage AC Mains Port, per CISPR 14, 16.
- 3) DC Power Port, per CISPR 16.
- 4) Telecom / Network Port, per CISPR 22.

Note: This is a Class B product.

## STATUS INDICATORS

**Run (Green) -** Constant ON indicates power is applied and unit is operating normally. Flashing ON/OFF indicates that unit is performing diagnostics (first second following power-up), or has failed diagnostics (after a few seconds).

**Overrange (Yellow, Each Channel) -** ON if input out of range.

## HOST COMPUTER COMMUNICATION

**Host Communication Port (SPI):** IntelliPack SPI port (standard RJ11 6-wire phone jack). See Drawing 4501-721 for location. Configuration information is downloaded from the host computer through one of its EIA232 serial ports. This port must be connected to the module through an Acromag IntelliPack Serial Port Adapter. This Serial Port Adapter

serves as an isolated interface converter between EIA232 and the IntelliPack's SPI port.

**Baud Rate (EIA232):** 19.2K baud.

## SOFTWARE CONFIGURATION

Units are fully reprogrammable via our user-friendly Windows 95/98® or NT® IntelliPack Configuration Program (Model 5030-881). Programmable attributes for this model are given below. A cable (5030-902) and converter (5030-913) are required to complete the interface (Software Interface Package 800C-SIP). See Drawing 4501-643. Additional information can be found in the IntelliPack Transmitter Configuration Manual (8500-570).

### Input Configuration

**Input - Range (Each Input):** The transmitter can be configured to accept any one of the five input range types shown below. However, a short jumper wire must be installed between the input "I+" and "V+" terminals to utilize current input. Input range volts and milliamperes can be scaled to engineering units per your application (see Transmitter Configuration).

**Voltage:** 0 to 10V DC, 0 to 5V DC.

**Current (Jumper Required):** 0-20mA, 4-20mA, or 0-1mA DC.

**Input Calibration (Each Input, Each Range):** The IntelliPack Configuration Software is used to calibrate available input ranges at each input channel of this module.

### Output Configuration

**Output - Range:** Analog output can be configured for one of five ranges of current or voltage. For voltage output, a jumper must also be installed between the output "I+" and "JMP" terminals (remove this jumper for current output).

**Voltage (Jumper Required):** 0 to 10V DC, 0 to 5V DC.

**Current:** 0 to 20mA DC, 4 to 20mA DC, or 0 to 1mA DC.

**Output - Mode:** Select a Normal Acting (ascending), or Reverse Acting (descending) output response.

**Output Calibration:** The configuration software can be used to calibrate the output conditioning circuit of this module.

### Transmitter Configuration

**Transmitter - Scaling:** Scaled values must be entered for each input to translate the nominal zero and full-scale input range endpoint values indicated, to engineering units per the requirements of your application. Up to 8 characters may be used to specify constants and scientific notation is supported. Up to 6 characters may be used to describe the engineering units of the scaled input and output values. For example, a 4-20mA input signal range may be scaled to 0 to 5000 GPM. The equation only operates on the equivalent scaled input values. The computed output value is also scaled to nominal zero and full-scale output range endpoint values for the voltage or current output range selected.

**Transmitter - Equation:** Up to 200 characters may be used to specify an output equation that is the mathematical combination of up to four inputs (894M), or two inputs (892M). A free-form equation is entered in "in-fix" notation that uses floating-point constants, scaled input channel variables, standard operators (+, -, \*, /, ( )), plus square root (SQR( )), absolute value (ABS( )), minimum select (MIN( )), maximum select (MAX( )), exponential (EXP( )), natural logarithm (LN( )), logarithm base 10 (LOG10( )), power (POWER( )), sine (SIN( )), cosine (COS( )), tangent (TAN( )), arc sine (ASIN( )), arc cosine (ACOS( )), and arc tangent

(ATAN( )). Support for IF-THEN-ELSE, plus AND & OR, >, >=, <, <=, =, <> constructs are included.

Constants are single precision floating-point values (scientific notation supported) and are limited to 8 characters. The computed output is then scaled to nominal output range endpoints.

**Transmitter - Show Simulator:** The Show Simulator function is used to test your equation and ensure that a correct output response within range is produced, without having to drive the inputs with real world signals. Slide controls are provided to vary simulated input signals (click and drag with your mouse). Fine control of the slide controls is also possible via your arrow keys. Error checking in this area is limited and it is up to the user to verify correct formulation for all possible conditions of input and output. As such, use of the Show Simulator function is highly recommended for critical control applications.

**Visual Over-Range Indicator:** A yellow LED for each channel provides visual status indication of when the input signal is out of range (LED is ON for over-range).

**Output HOLD Function:** A TTL or open collector/drain signal (5V logic) may be wired directly to the HOLD terminal of the module to hold the transmitter's output at the last value. HOLD is asserted low (with respect to COM) and pulled-up internally. The HOLD circuit is part of the input circuit and isolated from the output circuit.

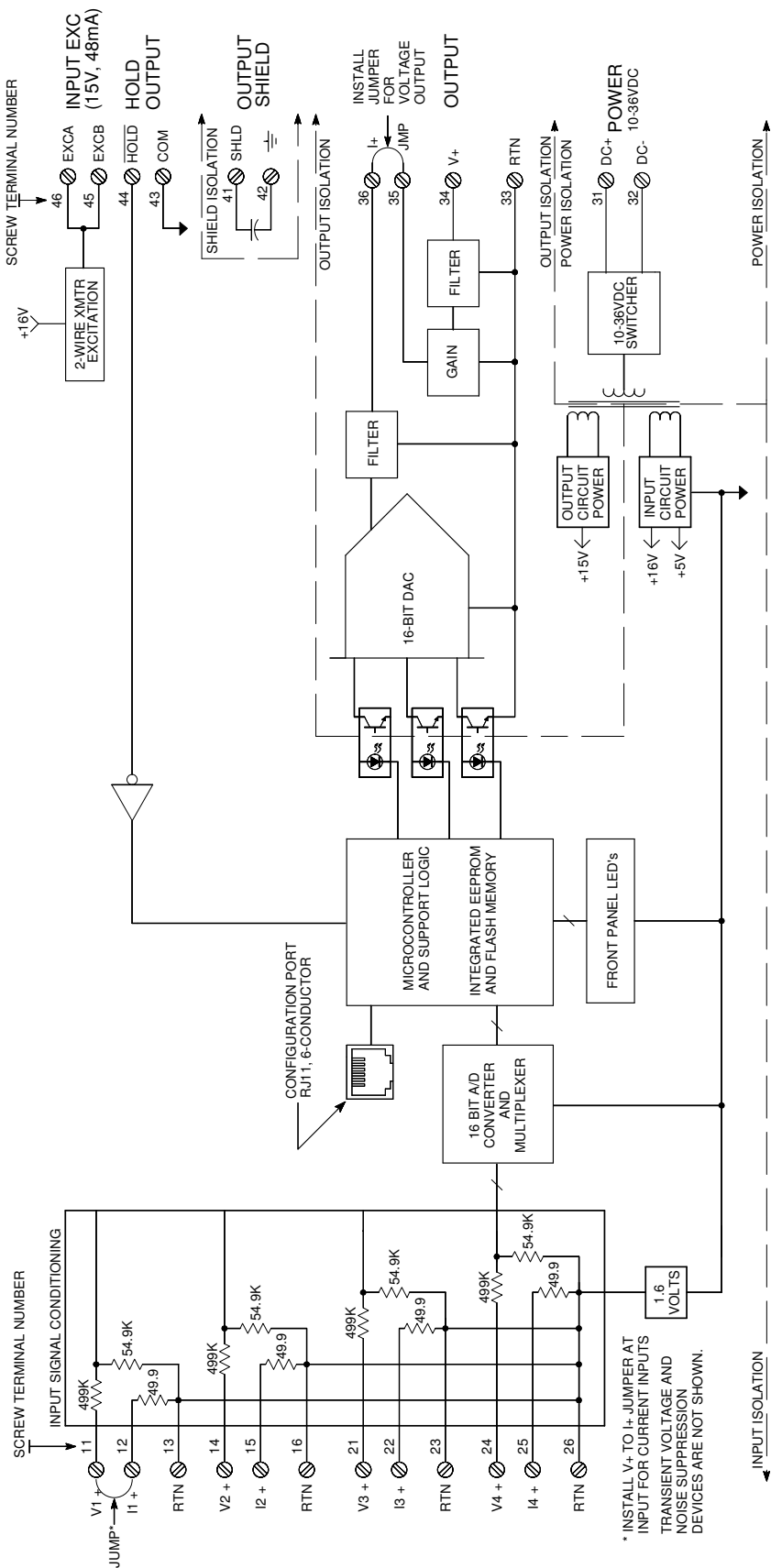
**WARNING:** Input return (RTN) and common (COM) are not equivalent potentials and should never be tied together. Make sure that common is not inadvertently tied to ground which may connect to input return.

### Other IntelliPack Configuration Software Capabilities

In addition to configuring all features of the module described above, the IntelliPack Configuration Software includes additional capabilities for testing and control of the module as follows:

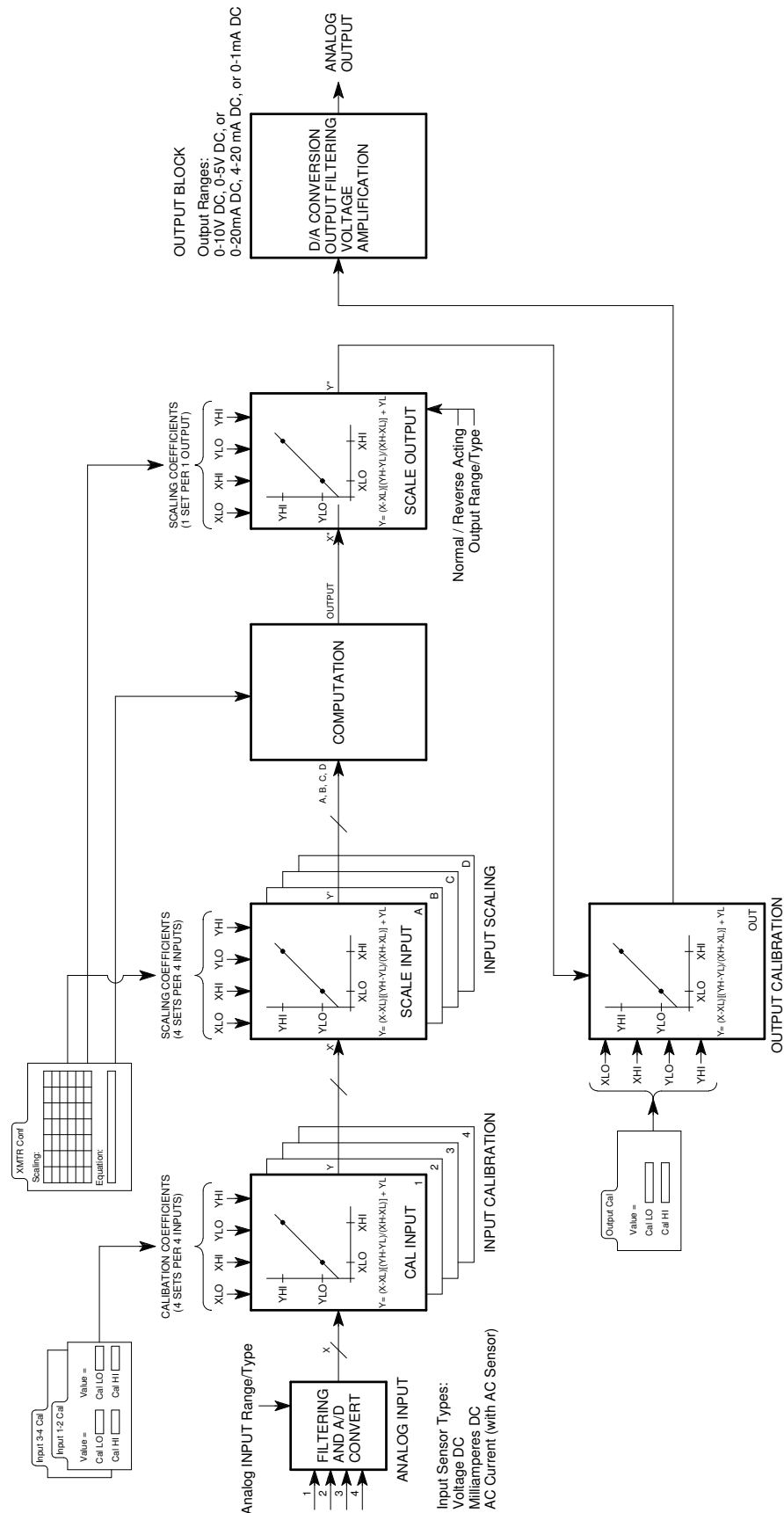
- Monitors the input and output signal values and allows polling to be turned on or off.
- Provides a "Show Simulator" function to simulate input variations and test the programmed equation.
- Allows a configuration to be uploaded or downloaded to/from the module. Also provides a means to rewrite a module's firmware if the microcontroller is replaced or a module's functionality is updated.
- Provides controls to separately calibrate the input and output stages and restore the original factory input or output calibration in case of error.
- Provides a control to reset a module.
- Provides a control to adjust a transmitter's output signal independent of the input signals (includes timed override).
- Allows optional user documentation information to be written to the module. Documentation fields are provided for tag number, comment, configured by, location, and identification information. This information can also be uploaded from the module and printed via this software.
- Allows a module's complete configuration to be printed in an easy to read, two-page form, including user documentation.
- Includes on-line help and context (field) sensitive help functions.

For additional information on the IntelliPack Configuration Software, refer to the Transmitter Configuration Manual 8500-570.



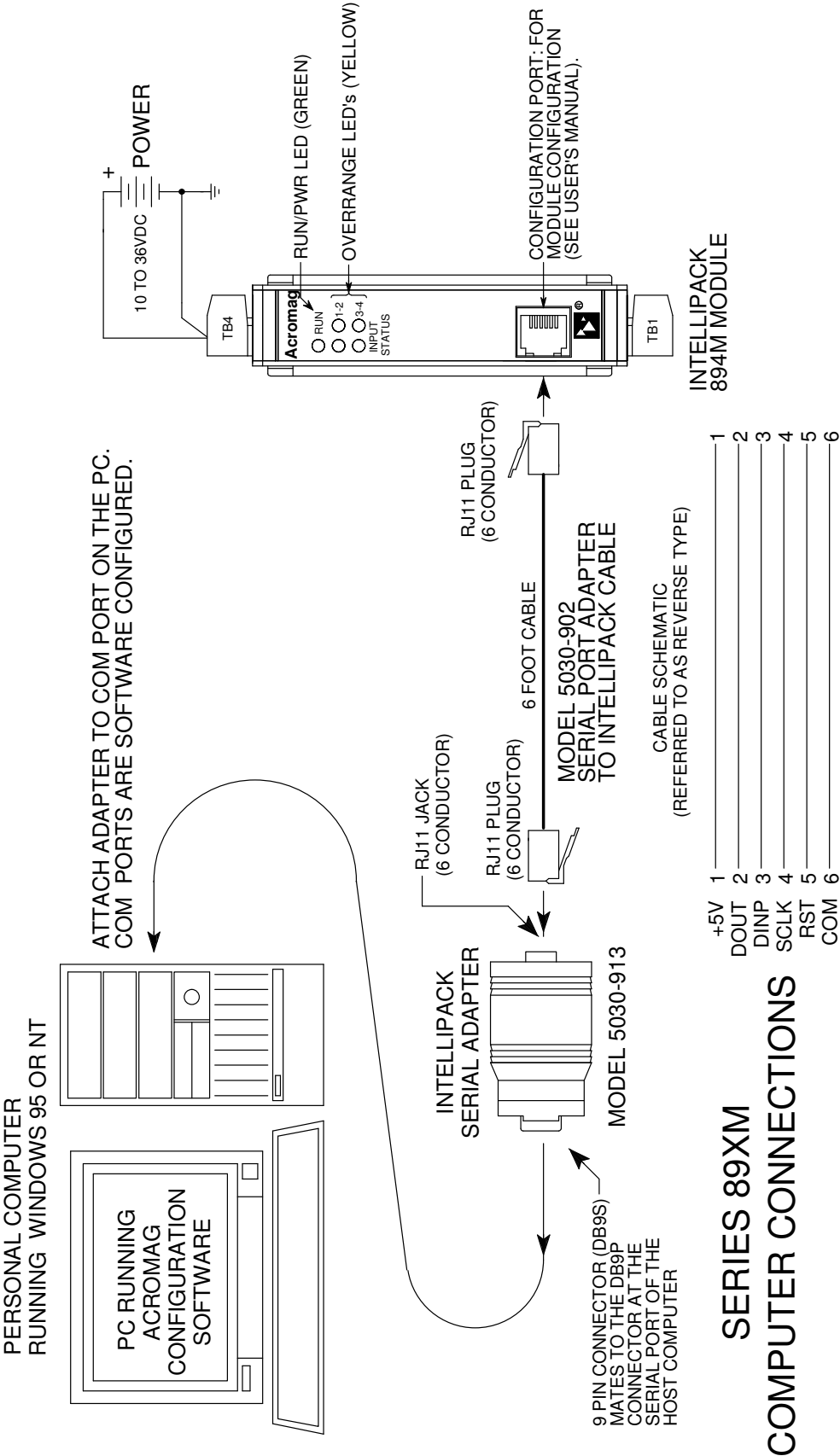
SERIES 894M SIMPLIFIED SCHEMATIC

4501-717A

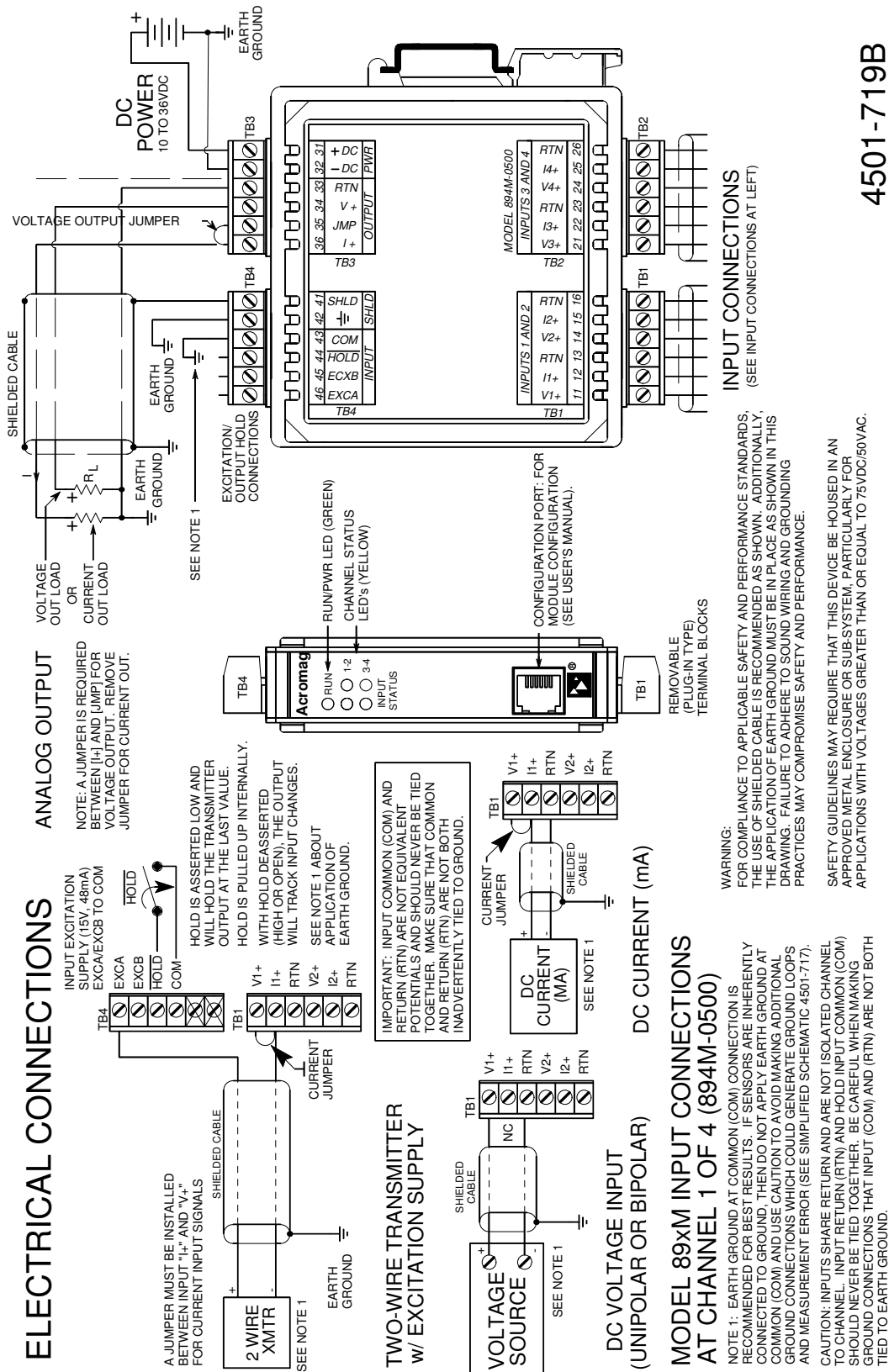


MODEL: 894M-0500 / 892M-0500  
COMPUTATION TRANSMITTER  
FUNCTIONAL BLOCK DIAGRAM

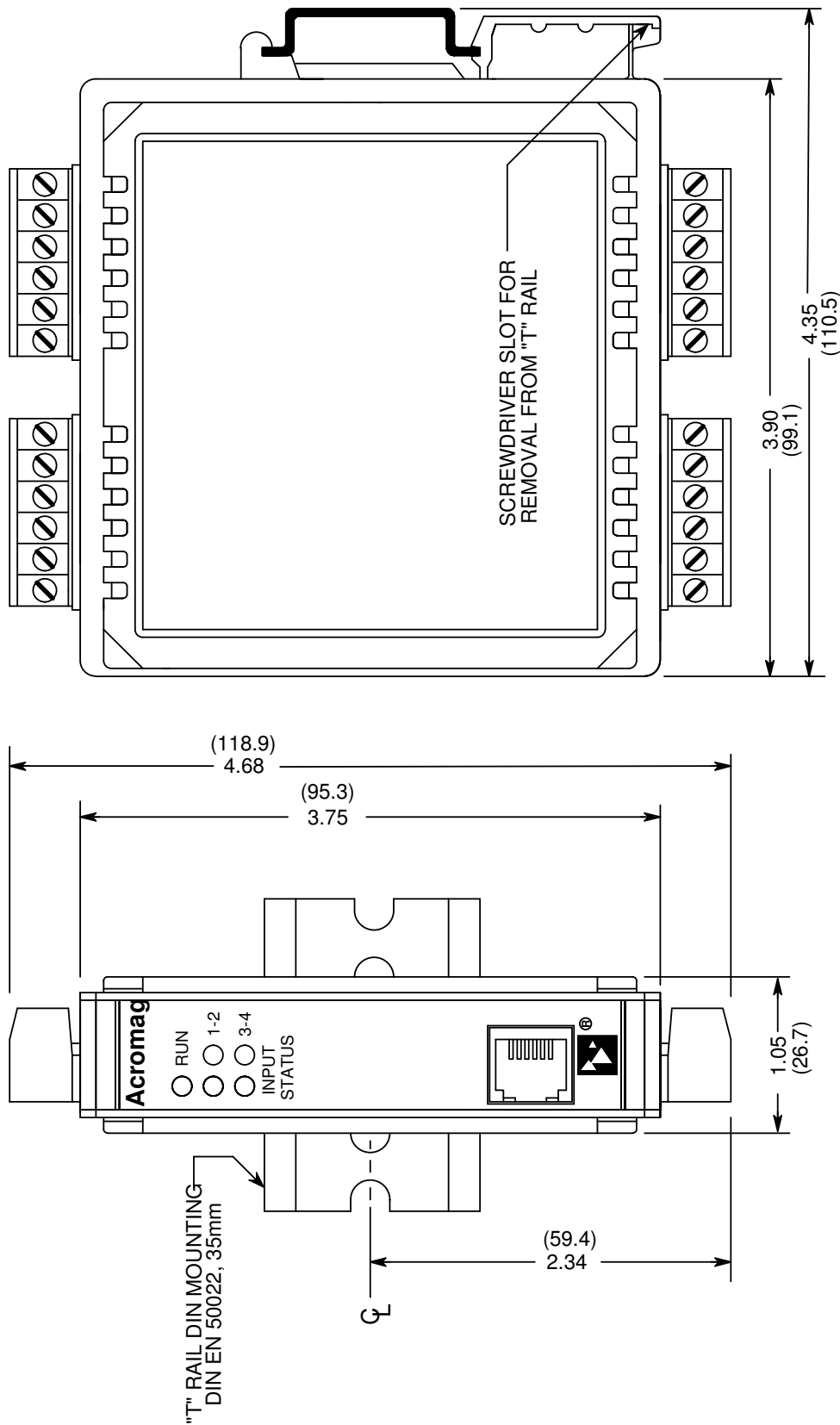
4501-718A



4501-721A



4501-719B



NOTE: ALL DIMENSION ARE IN INCHES (MILLIMETERS)

INTELLIPACK TRANSMITTER  
ENCLOSURE DIMENSIONS

4501-720A